

# Homa Esfahanizadeh

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## RESEARCH VISION

My research interests broadly include information and coding theory, communication networks, machine learning, data privacy, and distributed computation. My research addresses various practical risk factors in data communication and processing over large-scale information systems. These issues include delays and failures in communication and computation, system heterogeneity and uncertainties, resource costs, and privacy concerns, and they arise in many modern applications such as communication networks (5G and beyond), cloud infrastructure, smart cities, machine learning, etc. I tackle these challenges from an information-theoretical perspective to propose practical solutions that have theoretical motivations and guarantees.

## EDUCATION

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|---|-------------------------|
| <b>Post-Doctoral Program, EECS Department, MIT RLE</b><br>Massachusetts Institute of Technology (MIT)<br>Advisor: Muriel Médard   | Mar. 2020-<br>Dec. 2023 |
| <b>Ph.D, Electrical Engineering, Signals and Systems</b><br>University of California, Los Angeles (UCLA)<br>Advisor: Lara Dolecek<br>Thesis: Spatially-coupled codes for modern data storage systems                  | Sep. 2015-<br>Dec. 2019 |
| <b>M.Sc, Electrical Engineering, Communication Systems</b><br>University of Tehran (UT)<br>Advisors: Farshad Lahouti<br>Thesis: Topological interference management in multiple unicast networks through index coding | Sep. 2012-<br>Jul. 2015 |
| <b>B.Sc, Electrical Engineering, Telecommunications</b><br>University of Tehran (UT)<br>Advisor: Farshad Lahouti<br>Thesis: Fixed-point implementation of turbo decoder on DSP  | Sep. 2008-<br>Jul. 2012 |

## RESEARCH EXPERIENCES

### Research Scientist

Radio Systems Research Group, Nokia Bell Labs

I design semantic communication solutions that are tailored to align with the specifications of a communication network.

### Post-Doctoral Research Associate

Laboratory of Electronics (RLE), MIT

I developed fast, reliable, and adaptable solutions for data communication and computation over large-scale information systems.

### Graduate Student Researcher

Laboratory for Robust Information Systems (LORIS), UCLA

I presented novel frameworks for efficient analysis and design of low-latency error-correcting codes, suitable for modern communication and storage applications.

### Graduate Student Researcher

Wireless Multimedia Communication (WMC) Laboratory, University of Tehran

I elaborated the optimum mapping between the problems network coding, index coding, and matrix completion.

## TEACHING EXPERIENCE

Instructor for

- **Oral communication (6.UAT)**, Massachusetts Institute of Technology (MIT), Spring 2022.

Guest Lecturer for

- **Principles of digital communication**, Massachusetts Institute of Technology (MIT), Fall 2021.
- **Probability and statistics**, University of California, Los Angeles (UCLA), Fall 2017.

Course Teacher Assistant for

- **Mathematical foundations of data storage systems**, University of California, Los Angeles (UCLA), Summer 2019.
- **Probability and statistics**, University of California, Los Angeles (UCLA), Fall 2017.
- **Communication systems**, University of California, Los Angeles (UCLA), Spring 2017.
- **Wireless multimedia communication theory**, University of Tehran, Spring 2013 and Spring 2014.

Laboratory Instructor Assistant for

- **Multimedia Communication Laboratory intended for undergraduate and graduate students**, University of Tehran, Spring 2014.
- **Microprocessor Laboratory intended for undergraduate students**, University of Tehran, Fall and Spring 2012 -2013.

## MENTORSHIP EXPERIENCE

At Massachusetts Institute of Technology (MIT):

- Co-advised with Prof. M. Médard these M.Eng students:
  - Andrea Jaba, thesis title: “Random Sequential Encoders for Private Data Release in NLP”.
  - William Wu, thesis title: “Neural Data Shaping and Evaluation via Mutual Information Estimation” (winner of MIT’s best master thesis award).
- Mentored Alexander Mariona (Ph.D student).

At University of California, Los Angeles (UCLA):

- Mentored Lev Taus (Ph.D student), Jose Suarez (Visitor Ph.D student), Ruiyi Wu (Master student), and Andrew Tan (Undergrad student).

## INTERNSHIP EXPERIENCE

Decoder design of LDPC codes for 5G cellular networks using Reinforcement Learning, Samsung Research America, San Diego, CA, Summer 2018.

## HONORS AWARDS

- Best paper runner up at the IEEE International Conference on Cloud Networking (CloudNet) for the paper “Distributed computations with layered resolution”, Nov. 2022.
- Memorable paper award at the Non-Volatile Memories Workshop (NVMW) for the paper “Non-uniform windowed decoding for multi-dimensional spatially-coupled LDPC codes ” ([news on UCSD website](#)), March 2021.
- Dissertation Year Fellowship (DYF), University of California, Los Angeles (UCLA), ECE Department, 2018.
- Memorable paper award at the Non-Volatile Memories Workshop (NVMW) for the paper “A three-stage approach for designing non-binary spatially-coupled codes for Flash memories” ([news on UCSD website](#)), March 2018.
- University fellowship, University of California, Los Angeles (UCLA), ECE Department, 2015.
- Ranked as top 10 percent among the B.Sc. students of Electrical Engineering in the year 2012, University of Tehran.
- Ranked as third in national robocup soccer simulation competition, Iran, 2006.
- Selected among Iranian high school students to participate in the rescue league of robocup international champion, Bremen, Germany, 2006.

## SERVICES

- Supervisor of International High-School Students, MIT, Summer 2022 and 2023.
- Technical Program Committee: IEEE International Conference on Communications (ICC), 2023.
- Organizer of weekly group series for paper reading at MIT, focused on “Private Data Release”, 2022.
- Technical Program Committee: Non-Volatile Memories Workshop (NVMW) 2021.
- Journal reviewer: Elsevier Physical Communication, IEEE Communications Letters, IEEE BITS Magazine, IEEE Transactions on Communications (TCOM), IEEE Transactions on Information Theory (T-IT), IEEE Transactions on Magnetism (TMAG), IEEE Journal on Selected Areas in Information Theory (JSAIT), and IEEE Transactions on Very Large Scale Integration (VLSI) Systems.
- Conference reviewer: IEEE ICASSP, IEEE ICC, IEEE ISIT, IEEE ITW, NVMW, and IEEE Intermag.

## JOURNAL PUBLICATIONS

- **H. Esfahanizadeh**, A. Cohen, S. Shamai, M. Médard, “Successive refinement in large-Scale computation: Advancing model inference applications,” *IEEE Transactions on Signal Processing*, 2024 (under review).
- **H. Esfahanizadeh**, L. Tauz, and L. Dolecek, “Harnessing degrees of freedom of spatially coupled graph codes for agile data storages,” *IEEE BITS the Information Theory Magazine*, 2024.
- E. Dias, Duarte Raposo, **H. Esfahanizadeh**, A. Cohen, T. Ferreira, M. Luís, S. Sargento, M. Médard, “Sliding window network coding enables neXt generation URLLC millimeter-wave networks,” *IEEE Networking Letters*, 2023.

- **H. Esfahanizadeh (co first author)**, E. Ram (co first author), Y. Cassuto, L. Dolecek, “A unified, SNR-aware SC-LDPC code design with applications to magnetic recording,” *IEEE Transactions on Magnetics*, 2022.
- A. Cohen (co first author), G. Thiran (co first author), **H. Esfahanizadeh (co first author)**, and M. Médard, “Stream distributed coded computing,” *IEEE Journal on Selected Areas in Information Theory (JSAC-IT) as a Special Issue on Coded Computing*, 2021.
- Alejandro Cohen, **H. Esfahanizadeh**, B. Sousa, J. P. Vilela, M. Luís, D. Raposo, F. Michel, S. Sargento, and M. Médard, “Bringing network coding into SDN: A case-study for highly meshed heterogeneous communications,” *IEEE Communications Magazine (COMMAG)*, 2021.
- **H. Esfahanizadeh**, L. Tauz, and L. Dolecek, “Multi-dimensional spatially-coupled code design: Enhancing the cycle properties,” *IEEE Transactions on Communications (TCOM)*, 2020.
- **H. Esfahanizadeh**, A. Hareedy, and L. Dolecek, “Finite-length construction of high performance spatially-coupled codes via optimized partitioning and lifting,” *IEEE Transactions on Communications (TCOM)*, 2019.
- **H. Esfahanizadeh**, A. Hareedy, Ruiyi Wu, Rick Galbraith, and L. Dolecek, “Spatially-coupled codes for channels with SNR variation,” *IEEE Transactions on Magnetics (TMAG)*, 2018.
- **H. Esfahanizadeh**, A. Hareedy, and L. Dolecek, “Spatially-coupled codes optimized for magnetic recording applications,” *IEEE Trans. on Magnetic*, 2017.
- B. Amiri, A. Reiszadeh, **H. Esfahanizadeh**, J. Kliever, and L. Dolecek, “Optimized design of finite-length separable circulant-based spatially-coupled codes: An absorbing set-based analysis,” *IEEE Trans. on Commun. (TCOM)*, 2016.

## CONFERENCE PUBLICATIONS

- H. Kaan Kale (co first author), **H. Esfahanizadeh (co first author)**, N. Elias, O. Baser, M. Medard, S. Vishwanath, “TexShape: Information theoretic sentence embedding for language models,” *IEEE International Symposium on Information Theory (ISIT)*, 2024 (under review).
- Z. Zhong, M. Yang, J. Lang, C. Williams, L. Kronman, A. Sludds, **H. Esfahanizadeh**, D. Englund, M. Ghobadi, “Lightning: A reconfigurable photonic-electronic smartnic for fast and energy-efficient inference,” *SIGCOMM*, 2023.
- A. Mariona, **H. Esfahanizadeh**, R. D’Oliveira, and M. Médard, “A non asymptotic analysis of mismatched guesswork”, *IEEE International Symposium on Information Theory (ISIT)*, 2023.
- **H. Esfahanizadeh (co first author)**, W. Wu (co first author), M. Ghobadi, R. Barzilay, M. Medard, “InfoShape: Task-based neural data shaping via mutual information,” *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2023.
- E. Dias, Duarte Raposo, **H. Esfahanizadeh**, A. Cohen, V. A. Vasudevan, T. Ferreira, M. Luís, S. Sargento, M. Médard, “Millimeter-wave testbed and modeling in neXt generation URLLC communications,” *IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM)*, 2023.

- Z. Zhong, M. Yang, J. Lang, C. Williams, L. Kronman, A. Sludds, **H. Esfahanizadeh**, D. Englund, M. Ghobadi, “Lightning: A reconfigurable photonic-electronic SmartNIC for fast and energy-efficient inference”, *ACM SIGCOMM Conference*, 2023.
- **H. Esfahanizadeh**, A. Cohen, M. Médard, and S. Shamai, “Distributed computations with layered resolution,” *IEEE International Conference on Cloud Networking (CloudNet)*, 2022.
- A. Mariona, **H. Esfahanizadeh**, R. D’Oliveira, and M. Médard, “A bivariate invariance principle,” *IEEE Information Theory Workshop (ITW)*, 2022.
- **H. Esfahanizadeh**, A. Cohen, M. Médard, “Stream iterative distributed coded computing for learning applications in heterogeneous systems,” *IEEE International Conference on Computer Communications (INFOCOM)*, 2022.
- **H. Esfahanizadeh (co first author)**, E. Ram (co first author), Y. Cassuto, and L. Dolecek, “Spatially coupled codes with sub-block locality: Joint finite length-asymptotic design approach,” *IEEE International Symposium on Information Theory (ISIT)*, 2020.
- L. Tauz, **H. Esfahanizadeh**, and L. Dolecek, “Non-uniform windowed decoding for multi-dimensional spatially-coupled LDPC codes,” *IEEE International Symposium on Information Theory (ISIT)*, 2020.
- **H. Esfahanizadeh**, Ruiyi Wu, and L. Dolecek, “A finite-length construction of irregular spatially-coupled codes,” *IEEE Information Theory Workshop (ITW)* (invited paper), 2019.
- **H. Esfahanizadeh**, A. Hareedy, and L. Dolecek, “Multi-dimensional spatially-coupled code design through informed relocation of circulants,” *Allerton Conference on Communication, Control, and Computing (ALLERTON)*, 2018.
- A. Hareedy, **H. Esfahanizadeh**, and L. Dolecek, “Spatially-coupled code design for partial-response channels: Optimal object-minimization approach,” *IEEE Global Communications Conference (GLOBECOM)*, 2018.
- A. Hareedy, **H. Esfahanizadeh**, and L. Dolecek, “High performance non-binary spatially-coupled codes for Flash memories,” *IEEE Information Theory Workshop (ITW)*, 2017.
- **H. Esfahanizadeh**, A. Hareedy, and L. Dolecek, “A novel combinatorial framework to construct spatially-coupled codes: Minimum overlap partitioning,” *IEEE International Symposium on Information Theory (ISIT)*, 2017.
- **H. Esfahanizadeh**, A. Hareedy, and L. Dolecek, “The finite length analysis of spatially-coupled codes for 1-D magnetic recording channels,” *Asilomar Conference on Signals, Systems, and Computers (ASILOMAR)*, 2016.
- **H. Esfahanizadeh**, F. Lahouti, and B. Hassibi, “A matrix completion approach to linear index coding problem,” *IEEE Information Theory Workshop (ITW)*, 2014.

## PREPRINTS

- **H. Esfahanizadeh**, A. Yala, R. G D’Oliveira, A. Jaba, V. Quach, K. R. Duffy, T. S Jaakkola, V. Vaikuntanathan, M. Ghobadi, R. Barzilay, M. Médard, “PEOPL: Characterizing privately encoded open datasets with public labels,” arXiv 2304.00047, 2023.

- A. Yala, Victor Quach, **H. Esfahanizadeh**, R. D'Oliveira, K. Duffy, M. Médard, T. Jaakkola, R. Barzilay, “Syfer: Neural obfuscation for private data release,” arXiv 2201.12406, 2022.
- A. Yala (co first author), **H. Esfahanizadeh (co first author)**, R. Oliveira, K. Duffy, M. Ghobadi, T. Jaakkola, V. Vaikuntanathan, R. Barzilay, M. Médard, “NeuraCrypt: hiding private health data via random neural networks for public training,” arXiv 2106.02484, 2021.

## WORKSHOP PUBLICATIONS

- L. Tauz, **H. Esfahanizadeh**, and L. Dolecek, “Non-uniform windowed decoding for multi-dimensional spatially-coupled LDPC codes,” *Non-Volatile Memories Workshop (NVMW)*, 2021, **Winner of memorable paper award**.
- **H. Esfahanizadeh**, A. Hareedy, and L. Dolecek, “Multi-dimensional spatially-coupled code design with improved cycle properties,” *Non-Volatile Memories Workshop (NVMW)*, 2019.
- A. Hareedy, **H. Esfahanizadeh**, and L. Dolecek, “A three-stage approach for designing non-binary spatially-coupled codes for Flash memories,” *Non-Volatile Memories Workshop (NVMW)*, 2018, **Winner of memorable paper award**.

## REFERENCES

Massachusetts Institute of Technology (MIT)

- Prof. Muriel Médard: [medard@mit.edu](mailto:medard@mit.edu)
- Prof. Manya Ghobadi: [ghobadi@csail.mit.edu](mailto:ghobadi@csail.mit.edu)
- Prof. Regina Barzilay: [regina@csail.mit.edu](mailto:regina@csail.mit.edu)

University of California, Los Angeles (UCLA)

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Technion - Israel Institute of Technology

- Prof. Yuval Cassuto: [ycassuto@ee.technion.ac.il](mailto:ycassuto@ee.technion.ac.il)
- Prof. Shlomo Shamai: [sshlomo@ee.technion.ac.il](mailto:sshlomo@ee.technion.ac.il)